AN2936
Application note

10 W SMPS with HV power MOSFET and the L6565 for three-phase industrial applications

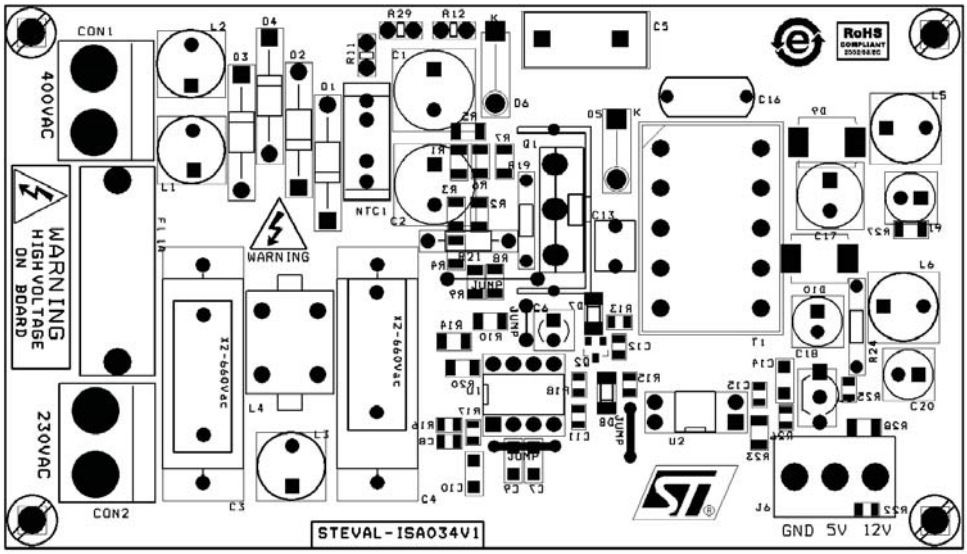
Introduction

This document introduces a solution for industrial power supplies fed by a three-phase mains. It uses a high voltage power MOSFET with 1500 V breakdown voltage to optimize the operation of a quasi-resonant flyback converter based on the primary controller L6565.

The STEVAL-ISA034V1 demonstration board has been designed and developed for low power applications. The board features two isolated outputs, 12 V and 5 V, and is capable of delivering up to 10 W.

The board can be ordered through order code STEVAL-ISA034V1.

Figure 1. 10 W board prototype



AM01332v1

Contents

1 Demonstration board description 3
1.1 Bill of materials 6
2 Related documents 9
3 Revision history 9

1 Demonstration board description

The STEVAL-ISA034V1 demonstration board is based on a quasi-resonant flyback converter topology and uses the STP3N150 1500 V power MOSFET as the primary switch. The STP3N150 employs STMicroelectronics' proprietary high voltage Mesh Overlay technology. Characteristic of this technology, the switch features very low $R_{DS(on)}$ per area, low gate charge and high switching performance. The device is available in the TO-220, TO-247 and TO-220FH packages.

The demonstration board is designed in accordance with the specifications in *Table 1*.

Table 1. Main specifications

Parameter	Value
Input voltage range	185 to 460 Vac
Input frequency range	50/60 Hz
Output 1	12 V @ 0.6 A
Output 2	5 V @ 0.55 A
Output power	10 W
Safety	EN60950
EMI	EN55014

The input section is equipped with two connectors: CON1 for 400 Vac input voltage, and CON2 for 230 Vac input voltage. The output voltages are available on CON3, with a shared ground between the two outputs.

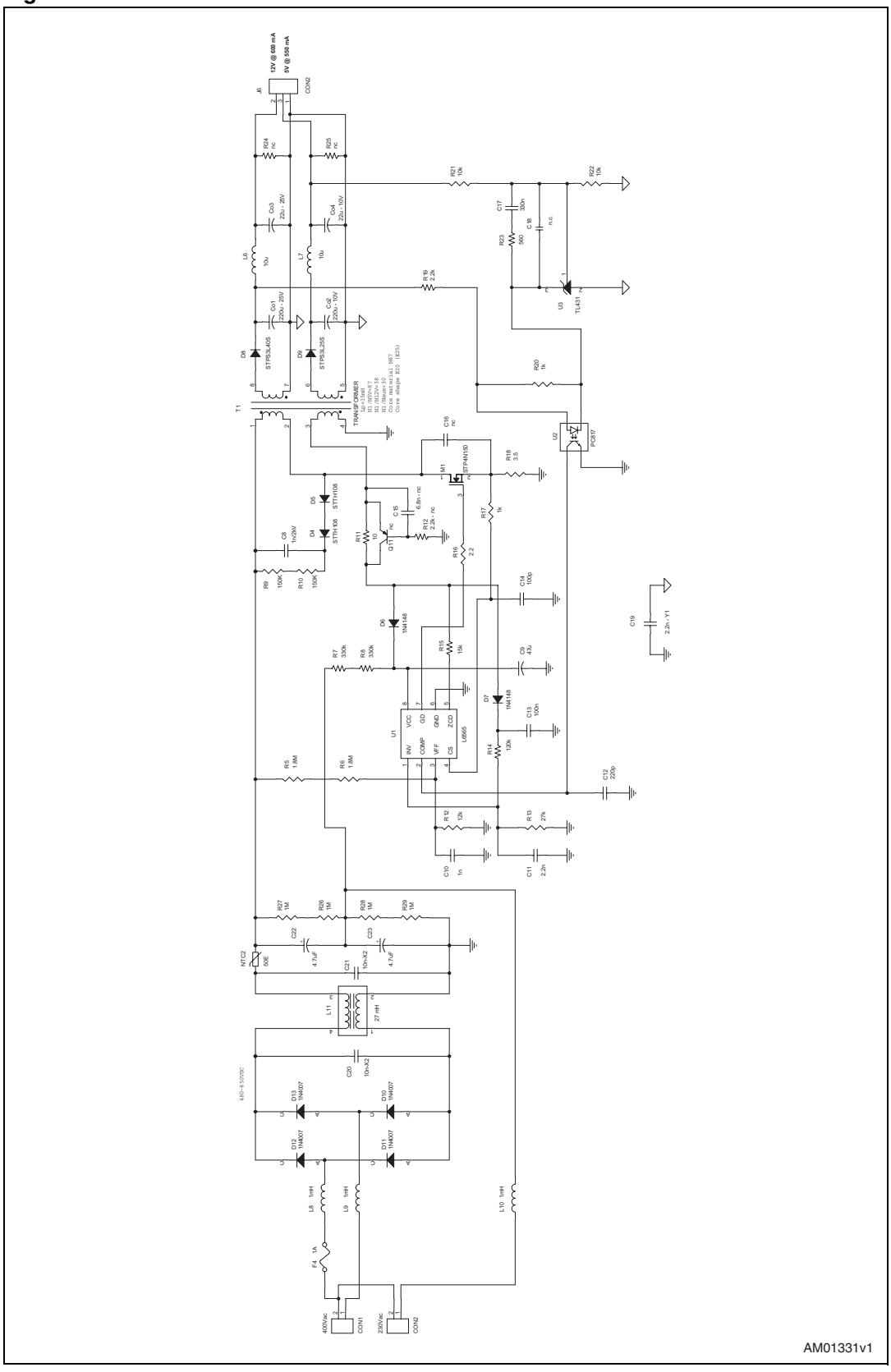
The converter is controlled by the L6565, a primary controller for quasi-resonant ZVS (zero-voltage switching) flyback converters. The device is capable of controlling power variations in the mains voltage by means of line voltage feed-forward. In light load conditions the device features a special function which automatically lowers the operating frequency while maintaining operation as close to ZVS as possible. In addition to very low startup and quiescent currents, this feature helps to maintain low consumption from the mains in light load conditions.

The device also includes a disable function, an on-chip filter on current sense, an error amplifier with a precise reference voltage for primary regulation and effective two-level overcurrent protection. The transformer reflected voltage is set to 400 V, providing enough margin for leakage inductance voltage spikes. A small RCD clamper circuit is used to limit excess voltage on the drain of the power MOSFET. During normal operation, the L6565 is powered by the auxiliary winding of the transformer, via diode D7. A spike killer circuit for the auxiliary voltage fluctuations is present, but not connected (Q2, C12, R15). The primary current is measured using an external sensing resistor (R21) for current mode operation. Output voltage regulation is performed using secondary feedback on the 5 V output.

The feedback network consists of a programmable voltage reference, TL431, driving an optocoupler which ensures the required insulation between the primary and secondary sections. The optotransistor drives the feedback pin (COMP), which controls the operation of the device. LC filters have been added on both of the outputs to reduce the high frequency ripple, using moderate output capacitor values.

The flyback transformer is a layer-type based on an E25/13/7 core and N27 ferrite, manufactured by Tronic, and ensures safety insulation in accordance with standard EN60950. The schematic of the board is shown in *Figure 2*. The power supply has been built on a double-sided 35 µm PCB in FR-4, size 120 x 68 mm. The bill of material is provided in *Table 3*.

Figure 2. Circuit schematic



1.1 Bill of materials

Table 2. Bill of materials

Reference	Value	Description
C1	4.7 µF - 450 V	Elect. capacitor
C2	4.7 µF - 450 V	Elect. capacitor
C3	10 nF - 660 V	Polip. capacitor X2
C4	10 nF - 660 V	Polip. capacitor X2
C5	1 nF - 2 kV	Polip. capacitor FKP
C6	47 µF - 50 V	Elec. capacitor
C7	1 nF - 50 V	Ceramic capacitor
C8	2.2 nF	Ceramic capacitor
C9	220 pF	Ceramic capacitor
C10	100 nF	Ceramic capacitor
C11	100 pF	Ceramic capacitor
C12	n.m.	Ceramic capacitor
C13	n.m.	Ceramic capacitor
C14	330 nF	Ceramic capacitor
C15	n.m.	Ceramic capacitor
C16	2.2 nF	Ceramic capacitor Y1
C17	220 µF – 25 V	Elec. capacitor 85 °C
C18	220 µF – 16 V	Elec. capacitor 85 °C
C19	22 µF- 25 V	Elec. capacitor
C20	22 µF- 25 V	Elec. capacitor
D1, D2, D3, D4	1N4007	Rectifier 1000 V 1 A
D5	STTH108	Turboswitch diode 1 A-800 V - STMicroelectronics
D6	STTH108	Turboswitch diode 1 A-800 V - STMicroelectronics
D7	LL4148/SOD-80	SOD-80 general-purpose rectifier 75 V 200 mA
D8	LL4148/SOD-80	SOD-80 general-purpose rectifier 75 V 200 mA
D9	STPS3L40S	Schottky rectifier 3 A-40 V
D10	STPS3L25S	Schottky rectifier 3 A-25 V
L1, L2, L3	1 mH	
L4	33 mH	Common mode choke
L5	10 µH	Inductor
L6	10 µH	Inductor
NTC1	50 Ω	NTC inrush current suppressor
F1	1 A	Fuse

Table 2. Bill of materials (continued)

Reference	Value	Description
R1	1 mΩ	Resistor, metal film 0.25 W 5%, SMD
R2	1 mΩ	Resistor, metal film 0.25 W 5%, SMD
R3	1 mΩ	Resistor, metal film 0.25 W 5%, SMD
R4	1 mΩ	Resistor, metal film 0.25 W 5%, SMD
R5	1.8 mΩ	Resistor, metal film 0.25 W 5%, SMD
R6	1.8 mΩ	Resistor, metal film 0.25 W 5%, SMD
R7	1.8 mΩ	Resistor, metal film 0.25 W 5%, SMD
R8	1.8 mΩ	Resistor, metal film 0.25 W 5%, SMD
R9	330 kΩ	Resistor, metal film 0.25 W 5%, SMD
R10	330 kΩ	Resistor, metal film 0.25 W 5%, SMD
R11	150 kΩ	Resistor, metal film 0.25 W 5%, SMD
R12	150 kΩ	Resistor, metal film 0.25 W 5%, SMD
R13	10 Ω	
R14	12 kΩ	Resistor, metal film 0.25 W 5%, SMD
R15	2.2 kΩ – n.m.	Resistor, metal film 0.25 W 5%, SMD
R16	18 kΩ	Resistor, metal film 0.25 W 5%, SMD
R17	120 kΩ	Resistor, metal film 0.25 W 5%, SMD
R18	15 kΩ	
R19	2.2 Ω	
R20	1 kΩ	
R21	3.5 Ω	
R22	2.2 kΩ	
R23	1 kΩ	
R24	10 kΩ	
R25	10 kΩ	
R26	560 Ω	
R27	n.m.	
R28	n.m.	
R29	150 kΩ	Resistor, metal film 0.25 W 5%, SMD
R30	1.2 kΩ	
T1	0603261	Switch mode transformer - Tronic
U1	L6565	Quasi resonant controller - STMicroelectronics
U2	PC817	Optocoupler
U3	TL431	Programmable shunt voltage reference 1% - STMicroelectronics

Table 2. Bill of materials (continued)

Reference	Value	Description
Q1	STP3N150	Power MOSFET 1500 V - 3 A - STMicroelectronics
Q2	BC547	Small signal PNP transistor

2 Related documents

1. AN1326: L6565 quasi-resonant controller

3 Revision history

Table 3. Document revision history

Date	Revision	Changes
16-Mar-2009	1	Initial release.

Please Read Carefully:

Information in this document is provided solely in connection with ST products. STMicroelectronics NV and its subsidiaries (“ST”) reserve the right to make changes, corrections, modifications or improvements, to this document, and the products and services described herein at any time, without notice.

All ST products are sold pursuant to ST’s terms and conditions of sale.

Purchasers are solely responsible for the choice, selection and use of the ST products and services described herein, and ST assumes no liability whatsoever relating to the choice, selection or use of the ST products and services described herein.

No license, express or implied, by estoppel or otherwise, to any intellectual property rights is granted under this document. If any part of this document refers to any third party products or services it shall not be deemed a license grant by ST for the use of such third party products or services, or any intellectual property contained therein or considered as a warranty covering the use in any manner whatsoever of such third party products or services or any intellectual property contained therein.

UNLESS OTHERWISE SET FORTH IN ST’S TERMS AND CONDITIONS OF SALE ST DISCLAIMS ANY EXPRESS OR IMPLIED WARRANTY WITH RESPECT TO THE USE AND/OR SALE OF ST PRODUCTS INCLUDING WITHOUT LIMITATION IMPLIED WARRANTIES OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE (AND THEIR EQUIVALENTS UNDER THE LAWS OF ANY JURISDICTION), OR INFRINGEMENT OF ANY PATENT, COPYRIGHT OR OTHER INTELLECTUAL PROPERTY RIGHT.

UNLESS EXPRESSLY APPROVED IN WRITING BY AN AUTHORIZED ST REPRESENTATIVE, ST PRODUCTS ARE NOT RECOMMENDED, AUTHORIZED OR WARRANTED FOR USE IN MILITARY, AIR CRAFT, SPACE, LIFE SAVING, OR LIFE SUSTAINING APPLICATIONS, NOR IN PRODUCTS OR SYSTEMS WHERE FAILURE OR MALFUNCTION MAY RESULT IN PERSONAL INJURY, DEATH, OR SEVERE PROPERTY OR ENVIRONMENTAL DAMAGE. ST PRODUCTS WHICH ARE NOT SPECIFIED AS "AUTOMOTIVE GRADE" MAY ONLY BE USED IN AUTOMOTIVE APPLICATIONS AT USER’S OWN RISK.

Resale of ST products with provisions different from the statements and/or technical features set forth in this document shall immediately void any warranty granted by ST for the ST product or service described herein and shall not create or extend in any manner whatsoever, any liability of ST.

ST and the ST logo are trademarks or registered trademarks of ST in various countries.

Information in this document supersedes and replaces all information previously supplied.

The ST logo is a registered trademark of STMicroelectronics. All other names are the property of their respective owners.

© 2009 STMicroelectronics - All rights reserved

STMicroelectronics group of companies

Australia - Belgium - Brazil - Canada - China - Czech Republic - Finland - France - Germany - Hong Kong - India - Israel - Italy - Japan - Malaysia - Malta - Morocco - Singapore - Spain - Sweden - Switzerland - United Kingdom - United States of America

www.st.com